

WHAT IS CLAIMED IS:

1 1. For use in a system including a light source, and a
2 light detector, for measuring one or more of at least two
3 target substances, each of the at least two target
4 substances including a chain of nucleotides, a sensor
5 comprising:
6 a) at least one optical carrier;
7 b) at least two optical cavities, each of the at
8 least two optical cavities
9 1) being optically coupled with the optical
10 carrier, and
11 2) having a surface including oligonucleotides
12 complementary to a particular one of the at least
13 two target substances,
14 wherein, when light is applied to the optical
15 carrier, a resonance within each of the optical cavities is
16 excited,
17 wherein, if a target substance hybridizes with
18 oligonucleotides on the surface of an optical cavity, a
19 shift in the resonance of that optical cavity occurs, and
20 wherein a measurement of the target substance can
21 be determined based on the shift in resonance.

1 2. The sensor of claim 1 wherein the optical carrier is an
2 optical fiber.

1 3. The sensor of claim 1 wherein at least one of the
2 optical cavities is a microsphere.

1 4. The sensor of claim 1 wherein at least one of the
2 optical cavities is a toroidal microcavity.

1 5. The sensor of claim 1 wherein at least one of the
2 optical cavities is a InP microdisk.

1 6. The sensor of claim 1 wherein at least one of the
2 target substances is DNA

1 7. The sensor of claim 1 wherein at least one of the
2 target substances is RNA

1 8. The sensor of claim 1 wherein, if a target substance
2 hybridizes with oligonucleotides on the surface of an
3 optical cavity surface, a shift in the resonance of that
4 optical cavity of a first amount occurs, and
5 wherein if a substance which differs from the target
6 substance by a single nucleotide is made available for
7 hybridization with the surface of the optical cavity
8 surface, a shift in the resonance of the optical cavity of
9 a second amount occurs, wherein the first amount is
10 detectably greater than the second amount.

1 9. The sensor of claim 8 wherein the first amount is at
2 least ten times greater than the second amount.

1 10. The sensor of claim 1 wherein the oligonucleotides
2 provided on at least one of the optical cavities are 11-mer
3 oligonucleotides.

1 11. The sensor of claim 1 wherein the oligonucleotides
2 provided on at least one of the optical cavities are at

3 least 27-mer oligonucleotides.

1 12. The sensor of claim 1 wherein the oligonucleotides
2 provided on at least one of the optical cavities are at
3 least 11-mer oligonucleotides.

1 13. The sensor of claim 1 wherein the oligonucleotides
2 provided on at least one of the optical cavities are at
3 most 27-mer oligonucleotides.

1 14. A system for measuring one or more of at least two
2 target substances, each of the at least two target
3 substances including a chain of nucleotides, the system
4 comprising:

5 a) a light source;

6 b) a light detector;

7 c) a sensor, the sensor including

8 1) at least one optical carrier optically
9 coupled with both the light source and the light
10 detector;

11 2) at least two optical cavities, each of the at
12 least two optical cavities

13 A) being optically coupled with the optical
14 carrier, and

15 B) having a surface including
16 oligonucleotides complementary to a
17 particular one of the at least two target
18 substances,

19 wherein, when the light source applies
20 light to the optical carrier, a resonance within
21 each of the optical cavities, having a first
22 characteristic, is excited and is detected by the

23 detector, and
24 wherein, if a target substance
25 hybridizes with oligonucleotides on the surface
26 of an optical cavity, a change in the
27 characteristic of the resonance of that optical
28 cavity occurs and is detected by the detector;
29 and
30 d) a processor for determining a measurement of the
31 target substance using a shift in the characteristic
32 of the resonances detected by the detector.

1 15. The system of claim 14 wherein the optical carrier is
2 an optical fiber.

1 16. The system of claim 14 wherein at least one of the
2 optical cavities is a microsphere.

1 17. The system of claim 14 wherein at least one of the
2 optical cavities is a toroidal microcavity.

1 18. The system of claim 14 wherein at least one of the
2 optical cavities is a InP microdisk.

1 19. The system of claim 14 wherein at least one of the
2 target substances is DNA

1 20. The system of claim 14 wherein at least one of the
2 target substances is RNA

1 21. The system of claim 14 wherein, if a target substance
2 hybridizes with oligonucleotides on the surface of an
3 optical cavity surface, a shift in the resonance of that

4 optical cavity of a first amount occurs, and
5 wherein if a substance which differs from the target
6 substance by a single nucleotide is made available for
7 hybridization with the surface of the optical cavity
8 surface, a shift in the resonance of the optical cavity of
9 a second amount occurs, wherein the first amount is
10 detectably greater than the second amount.

1 22. The system of claim 21 wherein the first amount is at
2 least ten times greater than the second amount.

1 23. The system of claim 14 wherein the oligonucleotides
2 provided on at least one of the optical cavities are 11-mer
3 oligonucleotides.

1 24. The system of claim 14 wherein the oligonucleotides
2 provided on at least one of the optical cavities are at
3 least 27-mer oligonucleotides.

1 25. The system of claim 14 wherein the oligonucleotides
2 provided on at least one of the optical cavities are at
3 least 11-mer oligonucleotides.

1 26. The system of claim 14 wherein the oligonucleotides
2 provided on at least one of the optical cavities are at
3 most 27-mer oligonucleotides.

1 27. The system of claim 14 wherein the processor
2 determines the measurement of the target substance using a
3 shift in characteristic of the resonances detected by the
4 detector, and refractive indices of the optical cavity and
5 a solution in which the target substance is allowed to come

6 into contact with the optical cavity.

1 28. The system of claim 27 wherein the processor
2 determines the measurement of the target substance further
3 using an excess polarizability of a volume of the target
4 over an equal volume of a solution in which the target is
5 provided.

1 29. The system of claim 14, wherein the optical cavity is
2 a microsphere, and
3 wherein the processor determines the measurement of
4 the target substance using a shift in characteristic of the
5 resonances detected by the detector, and a radius of the
6 microsphere.

1 30. The system of claim 14 wherein the measurement of the
2 target substance is a surface density of the target
3 substance bound to the optical cavity.

1 31. The system of claim 14 wherein the at least one
2 optical carrier includes a plurality of optical fibers.

1 32. The system of claim 31 wherein each of the plurality
2 of optical fibers is optically coupled with at least two of
3 the optical cavities.

1 33. The system of claim 31 further comprising at least one
2 additional light detector,
3 wherein at least two of the plurality of optical
4 fibers are optically coupled with a common light source,
5 but with different light detectors.

1 34. A method for measuring one or more of at least two
 2 target substances, each of the at least two target
 3 substances including a chain of nucleotides, using a system
 4 including, a light source, a light detector, and a sensor,
 5 the sensor including at least one optical carrier optically
 6 coupled with both the light source and the light detector
 7 and at least two optical cavities, each of the at least two
 8 optical cavities being optically coupled with the optical
 9 carrier, and having a surface including oligonucleotides
 10 complementary to a particular one of the at least two
 11 target substances, the method comprising:

- 12 a) applying light, using the light source, to the
- 13 optical carrier;
- 14 b) detecting, with the detector, at a first time, a
- 15 characteristic of a resonance excited within each of
- 16 the optical cavities, having a characteristic;
- 17 c) providing a solution which may include one or more
- 18 of the target substances in fluid contact with the
- 19 sensor;
- 20 d) detecting, with the detector, at a second time, a
- 21 change in the characteristic of the resonance of any
- 22 of the optical cavities; and
- 23 e) determining a measurement of the target substance
- 24 using a shift in characteristic of the resonances
- 25 detected by the detector.

1 35. The method of claim 34 wherein at least one of the
 2 target substances is DNA

1 36. The method of claim 34 wherein at least one of the
 2 target substances is RNA

1 37. A method for measuring one or more of at least two
2 target substances, each of the at least two target
3 substances including a chain of nucleotides, using a system
4 including, a light source, a light detector, and a sensor,
5 the sensor including at least one optical carrier optically
6 coupled with both the light source and the light detector
7 and at least two optical cavities, each of the at least two
8 optical cavities being optically coupled with the optical
9 carrier, and having a surface including oligonucleotides
10 complementary to a particular one of the at least two
11 target substances, the method comprising:

- 12 a) applying light, using the light source, to the
13 optical carrier;
- 14 b) detecting, with the detector, at a first time, a
15 resonance excited within each of the optical cavities,
16 having a characteristic;
- 17 c) applying a solution which may include one or more
18 of the target substances in fluid contact with the
19 sensor;
- 20 d) detecting, with the detector, at a second time, a
21 change in the characteristic of the resonance of two
22 of the optical cavities;
- 23 e) determining, for each of the two of the optical
24 cavities, a shift in the characteristic of the
25 resonances detected by the detector; and
- 26 f) determining a measurement of the target substance
27 using a difference of the shifts in characteristic of
28 the resonances detected by the detector.

1 38. The method of claim 37 wherein at least one of the
2 target substances is DNA

- 1 39. The method of claim 37 wherein at least one of the
- 2 target substances is RNA